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THE SANITATION OF A SMALL EUROPEAN SETTLEMENT IN PORTUGUESE EAST AFRICA; WITH NOTES ON SOME OF THE DISEASES PREVALENT IN THE DISTRICT.*

BY

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In April, 1913, I was sent by the Church of Scotland Blantyre Mission as one of a party to open up a new station in Portuguese East Africa, to the east of the Mission's present stations in British Nyasaland.

This paper is primarily an account of the measures taken for the sanitation of the new station, but the investigations recorded, undertaken in this connection, may be worthy of record as having a bearing on the distribution of some of the diseases prevalent in the district.

GEOGRAPHICAL. METEOROLOGICAL.

The station is situated about 160 miles east of the Nyasaland border, and about 30 miles south of the 15th south parallel of latitude, in the

*A thesis presented to the University of Glasgow for the degree of M.D., 1915, for which the degree, with commendation, was granted.

Portuguese administrative district of Alto Mólôcuê. It has an altitude of about 2,800 feet above sea level, the elevation of the country generally being lower than that of British Nyasaland, and the temperature consequently higher. The following table gives the monthly maximum and minimum, and average temperatures, and the monthly rainfall during a year of our residence. For these figures I am indebted to the Rev. James Reid, F.R.S.G.S., who has kept continuous records since the establishment of the station.

TABLE I.

Church of Scotland, Alto Mólôcuê.

Table of Temperatures and Rainfall.

Month.	Temperatures.			Rainfall (in inches).
	Highest Shade Temperature. Degrees Fahr.	Lowest Shade Temperature. Degrees Fahr.	Average for Month. Degrees Fahr.	
1914.				
February	84	71	75·7	7·97
March	82	67	74·3	10·35*
April	91	60	74·7	3·14
May	83	59	69·2	0·64
June	88	54	68 7	0·26
July	83	53	65·1	1·11
August...	91	57	72·5	0·29
September	94·5	60	80·3	0·09
October	96	63	81·1	0·01
November	94	58	77·7	5·05
December	97	68	81·5	6·49
1915.				
January	94	69	80·2	7·58

*Heavy storm on the 5th. Rain gauge overflowed.

POPULATION.

The natives are of the Bantu stock, and belong to the Alomwe tribe, who occupy a large portion of Portuguese East Africa north of the

Zambesi River. They are subdivided into smaller sections, such as Mihavani, Esherima, Makuwa, and others. The people in our immediate neighbourhood call themselves Esherima. They live in villages, which may be two to ten miles apart, each village consisting of from twenty to one hundred or more huts. The huts are very scattered, and the larger villages may occupy nearly a square mile of country. From the medical point of view the natives make good patients, when their confidence has once been won, but they have an instinctive distrust of European treatment. It was some months after my arrival here before the people in the surrounding villages could be persuaded to come to me for treatment.

The Europeans on the station numbered seven, including two children. The administration officials, who are few and scattered, are the only other Europeans in the district.

So far as I am aware, no systematic medical work has ever been done in this part of Portuguese East Africa before. A Portuguese Sleeping Sickness Commission visited the district in 1912, but up to the time of writing this I have been unable to obtain a copy of their report. Statements in text books of tropical medicine as to the existence of particular diseases in Portuguese East Africa, generally refer to the area south of the Zambesi, or to the European settlements on the coast. The district of Alto Mólôcuê was first occupied by the Portuguese administration so recently as six years ago.

MALARIAL FEVER.

In the selection of the site for the new station, my first consideration was, naturally, the freedom of the locality from the breeding places of mosquitoes. This consideration, however, has always to be made compatible, as far as possible, with a good water supply at a convenient distance, and a situation suitable for a vegetable garden. As there is practically no rainfall for six months of the year, this latter desideratum necessitates a soil more or less permanently damp, or sufficient water for irrigation purposes. A reference to the attached map at the end of the paper will shew the relation of the dwelling houses to the position of the garden and the well from which the water supply is drawn.

The station is situated on the top of a broad ridge, about 200 feet above the level of the surrounding country, and the wells and garden are

in a narrow valley about 100 feet lower than the houses. This valley contains several springs and some marshy ground, forming the source of a small stream, which runs permanently during the rains but is partially dry up to a mile below the station from August on to the end of December.

The two other stream beds, marked (1) and (2) on the map, were dry at the time the site was settled on (end of June), and no other possible sources of anopheline breeding grounds were found within a mile radius of the station, nor have since been found. Beyond that radius, however, and up to a distance of two miles, several such breeding places exist. The nearest village is about two and a half miles away.

A well was dug for the Europeans' water supply on the opposite slope of the valley from the houses on the station, and another was made farther down the stream for the use of the natives resident on the station. Two pools were left for the purpose of irrigating the garden. The rest of the swampy ground was then drained, and the stream bed cleaned out, defined, and straightened.

Mosquitoes were never numerous; they were, indeed, much less so than in most of the Mission's Nyasaland stations, where primary malarial infection is not common. The majority of the mosquitoes present were anophelines; culicines were very rare. Nevertheless, several cases of malaria occurred, four of them undoubtedly fresh infections. Two of the patients were children (one European and one native) who had been born on the station and had never been away from it. The first two cases occurred in January, 1914, and there were three cases in April. One case occurred in May, and one in June, both in native children, but these two latter were possibly relapses of old infections. In all these seven cases the simple tertian parasite was found in the blood.

My register of dispensary patients shews that a corresponding rise took place in the number of malarial patients from the villages, at the same time of the year; there was a noticeable increase in January and the following months, with a much larger rise in April, after which the attendances for malaria gradually fell. This year, 1915, a similar increase has occurred among the dispensary patients, in January.

A reference to the rainfall table will shew that the beginning of the increase in malaria takes place in the third month of the rains. It is to

be noted, however, that it is not till January that the rains begin to have any effect on the swampy ground and the streams, and consequently on the breeding places of anophelines. December is the driest month of the year for streams and marshy ground. The greatest incidence in malaria will be seen to coincide with the end of the rains, and the following month. In the Mission this was the time of year when anophelines were most numerous, and an explanation of this was afforded by the nature of their breeding grounds found in the neighbourhood.

The dry stream beds marked (1) and (2) frequently contained pools during the rains, but examinations of these very rarely shewed anopheline larvæ, though culicines were often found in the dirtier pools. In April, however, numerous anopheline larvæ were found in them, and I discovered that some of the pools persisted during May and part of June, though the upper reaches of the streams were dry. During January and February a few anopheline larvæ were found in places where the danger of their being washed away by the flush of rain did not exist, namely, in the Europeans' well and at the sides of the small drainage channels in the marshy ground below the garden, and these, doubtless, accounted for the few anopheline mosquitoes present at that time.

A few of the anophelines found in the district are being sent to Professor NEWSTEAD, F.R.S., of Liverpool University, who has kindly identified blood-sucking flies for me on a former occasion. One of the species being sent appears from the data I have at hand to be *Myzomyia funesta*. This mosquito was shewn by DANIELS to be the chief carrier of malaria in British Central Africa, and it is, therefore, likely to be the carrier here. It is a typical spring and fresh water breeder,[1] and the collections of water in the neighbourhood of the station in which anopheline larvæ have been found are almost wholly of the type which would precisely suit its requirements.

As to the human element in the chain of infection, that was always present in the natives who lived on the station. I took, on one occasion, specimens of the blood of the twenty-nine natives, children and adults, who are permanently on the station, and found malarial parasites in six of these. Parasites had also been found in several others during attacks of fever at various times. This permanent reservoir is liable to be supplemented at intervals by the natives' friends from the villages

coming to stay with them. If these friends are women they are almost inevitably accompanied by young children, who, as will be shewn later, are a nearly unfailing source of infection.

PREVENTIVE MEASURES.

From the time that the first cases of fever occurred, regular attention was paid to the sources of mosquitoes. The pools in the stream beds were filled up with earth and stones, and the drainage channels in the marsh were deepened and cleaned, or increased in number, according as best prevented the stagnation of water. Where the fall of water in the channels was not sufficient to prevent stagnation, these were swept down at regular intervals. Grass was kept short in the marshy area, so that fresh collections of water could be readily detected. The irrigation pools in the garden were kept free from weed, and the sides clean-cut so as to avoid shallow water at the edges. Such pools have been found by FRY, in India, to be less favourable to the breeding of mosquitoes than those with shallow margins and weed in which the surface-living anopheline larvæ can take refuge from their natural enemies.[2] Most of these measures had to be repeated at intervals during the rains, for fresh collections of water appeared in the marsh as the season proceeded, and each accession of heavy rain altered the character of the channels, washing out pools that had been filled up and forming fresh pools, often in new places.

When the rains were over, a final draining of all the pools left generally sufficed until the beginning of the next wet season. In some cases, however, I found that water which flowed freely at the end of the rains, became stagnant as the marsh or stream dried up, necessitating some fresh measures of drainage at various periods during the dry season. In some of these, the necessities of the case were met by filling up the channel altogether. Oiling of pools was never found practicable. Owing to heavy carriage and import duties, petroleum is too expensive for such use here. My experience, moreover, shews that in small pools the oil is washed out by the first shower of rain.

The Europeans' well is now being fitted with a pump, and when this has been done it will be completely closed in. The pools on the rocks, and the clay pits, shewn on the map, in which culicines were found

breeding, were filled up, and gave no further trouble, as there was no wash of water to scour them out again.

It was formerly considered that half a mile was beyond the normal flight of anophelines,[3] and one regarded breeding grounds outside that radius as having no influence on the malaria of a locality. Experiments in the Panama Canal Zone with dyed mosquitoes, however, have shewn that some species, at least, can travel a mile.[4] JAMES, in his mosquito work in Ceylon, has also noted in Colombo migrations of great numbers of mosquitoes whose nearest breeding grounds were nearly a mile away.[5] Other similar observations have been made. The possibility of such long flights, therefore, would have to be taken into consideration in the event of persistence of anophelines or malaria after all the nearer breeding places had been dealt with. It may be mentioned that since June, 1914, up to the present time (March, 1915), no cases of fresh infection have occurred on the station.

As has been noted, the natives living on the station, especially children, formed the source from which the infection was drawn by the mosquitoes. In the circumstances of the new station, this source, unfortunately, could not be avoided. A reference to the map will shew how closely the houses are surrounded by forest. Owing to official delays in our obtaining a lease of the land, we were unable to make a larger clearing, and as leopards were troublesome at the beginning of our occupation, the native staff were naturally unwilling to live farther away in the uncleared bush. When the station is permanently settled, houses for the native staff, especially where there are children concerned, will be built at a distance away from the European dwellings. It is essential, however, to have a certain number of natives living on the station. House-boys are indispensable to the European, and their dormitory must be near his house. Among the house-boys on the station, I have found malarial parasites on at least four occasions during attacks of fever. A certain amount of risk from this source is thus inevitable. The ordinary labourers formed a settlement on the banks of a stream about a mile away from the station,

The administration of quinine to patients was persisted in as long as possible, as much as a general prophylactic measure as for the treatment of the individual case. In Europeans quinine was continued for two months. In natives great difficulty is experienced whenever they feel

well, and a certain amount of compulsion or moral suasion, as best meets the case, has to be applied.

Mosquito nets were made the rule for Europeans. This precaution was specially liable to be neglected in circumstances like ours, where noisy and troublesome culicines are rare, and the silent, inconspicuous anophelines, biting mostly through the night, are apt not to be noticed. The keeping of bedroom doors and windows open at night more than compensates for the "stuffiness" of the mosquito net, and a covering of chicken netting on doorways and windows gives sufficient protection from wild animals and other possible dangers.

A testimony to the value of the mosquito net was incidentally afforded. On one occasion one of the European families were driven out of their bedroom in the middle of the night by an invasion of red ants, and had to spend the rest of the night in another room on improvised beds, without nets. Twelve days later, on the same day, two of the family went down with an attack of malaria, the parasite being recovered from the blood in both cases.

INVESTIGATION OF MALARIA OF THE DISTRICT.

In order to get an idea of the extent and nature of the malaria of the district, I examined 84 children from the nearest village ($2\frac{1}{2}$ miles from the station), representing the majority of the juvenile population. The spleen was palpated and blood slides made in each case. The details of the investigation are shewn in Table II, in the Appendix. The ages of the children ranged from $1\frac{1}{2}$ months to 14 years, but the majority were between 1 and 6 years old.

Malarial parasites were found in the blood of *72* children, *i.e.*, *85·7* per cent. of the total number.

Enlarged (*i.e.*, palpable) *Spleen* was found in *61* children, *i.e.*, *72·6* per cent. of the total.

Positive Evidence of Malarial Infection (*i.e.*, parasites or enlarged spleen or pigment in the mononuclear leucocytes) was found in *79* children, *i.e.*, *94·04* per cent. of the total.

Among the 72 positive blood slides:—

29, or *40·2* per cent. shewed *Malignant Tertian Parasite (Laverania malariæ)*.

43, or *59·7* per cent., shewed *Simple Tertian Parasite (Plasmodium vivax)*.

6, or *8·3* per cent., shewed *Quartan Parasite (Plasmodium malariæ)*.

In four cases the species of the parasite was uncertain. There were ten cases of mixed infection—seven cases of malignant with simple tertian, one case of malignant tertian with quartan, and two cases of simple tertian with quartan. Gametocytes were found in six cases.

The endemic index of the district is thus seen to be very high, and the liability of the European immigrant to infection in the villages will be very great. Mwanyewe's is a typical village, and has no special features which are not possessed by all native villages to predispose it to a high malarial endemicity.

A relative leucocyte count was made in the case of the five children who shewed no other signs of malaria. The results are shewn in the following Table. Five hundred leucocytes were counted in each case.

TABLE IIa.

Relative Leucocyte Count of Children shewing no other Signs of Malaria.

Number of Case.	Polymorphs.	Large mononuclears.	Lymphocytes.	Transitional.	Eosinophiles.	Basophiles.	Myelocytes.
32	15·8	52·6	16·0	13·8	1·6	0·2	—
35	50·4	26·4	17·0	4·6	1·2	0·4	—
37	40·4	42·4	8·6	3·4	5·2	—	—
52	47·4	32·0	3·6	3·2	13·4	0·4	—
55	22·8	50·0	19·6	5·2	1·8	0·2	0·4

It will be seen that in all the cases the percentage of large mononuclears is exceptionally high. A relative increase in the mononuclears has been noted in other protozoal diseases, and CASTELLANI and CHALMERS state that as a means of diagnosis in malaria a marked increase may arouse suspicions, but that by itself it is quite useless.[6] In the case of these native children, however, the increase is almost certainly due to malarial infection. In all the other cases a similar mononuclear increase could be noted on a cursory examination of the blood, and malaria is the only protozoal infection to which village children are universally liable. When the percentage infected is so high, it is unlikely that any should escape. One of the children on this list of five (No. 55) was brought to the dispensary six weeks later, suffering from a heavy infection of the malignant tertian parasite.

Examination of the blood for parasites is seen to reveal a higher percentage of malaria than palpation of the spleen. It is to be noted, however, that the investigation was made in January, when illness from fever begins to be common in the villages. If made in August or September, the positive findings from examination of the blood would probably not have been so numerous.

The higher percentage of the simple tertian parasite, as compared with the subtertian (malignant) form, is an interesting point. The Malaria Commission of the Royal Society to British Central Africa, in 1899, found only the malignant tertian parasite in the Blantyre district. The simple tertian form is now also found there, but it is not common. From the foregoing investigation, as well as from my experience of malaria on the station and among dispensary patients, the simple tertian form would appear to be the common one here. As, however, *Laverania malariæ* completes its schizogony in the internal organs, it is probable that the findings of the peripheral blood do not give a true index of its frequency.

One of the most remarkable points brought out by the examination, is the very large numbers of parasites which these native children are able, through the gradual development of immunity, to harbour in their blood without apparent symptoms. In one or two cases, parasites were present to the extent of two or three to every field of the microscope, and one to every two or three fields was fairly common. In Europeans,

in Central Africa, such large numbers are very uncommon in my experience. Symptoms in them are produced by much smaller numbers, and quinine treatment checks multiplication before it proceeds much further. It should be noted, nevertheless, that most native children suffer from malaria, from time to time, and the mortality among them from the malignant form is probably great.

From the large numbers of parasites which they are able to tolerate without untoward effects, one may draw the practical conclusion that in native children malaria is not necessarily the primary cause of any illness accompanied by fever, even though the malarial parasite may be demonstrated in the blood. As an illustration, I recall such a case in a child treated by me for malaria who returned on the following day with a commencing smallpox eruption.

INTESTINAL PARASITES.

Soon after beginning medical work among the natives here, I found that ankylostomiasis existed, and, knowing that the infection was fairly common in Nyasaland, I was anxious to find out to what extent it was present here. For this purpose I examined the fæces of 200 ordinary natives of the district. These were drawn mainly from the raw labour on the station, supplemented by house-boys and other permanent employees, dispensary ulcer patients and any villagers whom I could get hold of. I wished to get at least 500 cases, but having no hospital with patients in residence I found great difficulty in obtaining specimens, even with the offer of a small reward of calico for each contribution. The presence of other helminths was noted and tabulated at the same time, and the details of the investigation are shewn in Table III, in the Appendix. The figures in each column represent the number of ova found under a circular cover-glass, $\frac{7}{8}$in. in diameter; the maximum quantity of fæces which when mixed with water allowed sufficient clearness for the ova to be distinctly detected, being taken in each case. A rough estimate of the relative heaviness of each infection was thus made.

The results of the examination are shewn in the following Table :—

TABLE IV.

RESULTS OF EXAMINATION OF FÆCES OF ORDINARY POPULATION, ALTO MÓLÔCUÊ.

Parasite.	Number Examined.	Ova found in.	Percentage infected.
Ankylostoma duodenale or *Necator americanus* ..	200	194	97·0
Ascaris lumbricoides	200	128	64·0
Schistosoma (?) *mansoni*	200	4	2·0
Trichuris trichiura (trichocephalus)	200	29	14·5
Tænia sp. (?)	200	10	5·0

ANKYLOSTOMIASIS.

Ova of Ankylostoma or Necator were found in 194 cases, or 97 per cent. The number investigated is too small to enable one to speak definitely for the whole population over a large area, but it may be safely said that the percentage of the population infected is very large. The cases represented most of the villages within a radius of twenty miles of the station and many others beyond, up to a distance of fifty miles. Several women, with a number of children down to three years of age, were included in the investigation, and all of these gave positive findings. I examined independently a few children of two years of age and under, but found no ova.

For comparison with these findings I may quote the results of an investigation by Dr. STANNUS, of the Nyasaland Government Medical Service.[7] In 505 Nyasaland natives examined by him in Zomba (mostly prisoners and native troops), 22·1 per cent. were found infected. STANNUS quotes BASS as having shewn that by the method of examination of fæces for ova 20 cases per cent. were missed, and he, therefore, arrived at the figure of 42 as representing the probable true percentage of infected in Nyasaland.

In several of the cases of my own series, which gave negative results on the first examination, I had an opportunity of examining a second

specimen, and all of these except one gave positive findings—sometimes only after examining a second slide. It may well be, therefore, that the percentage of infected in this district is as high as 100.

Regarding the degree of infection, an estimate of the number of worms present may be attempted from the number of ova found. As quoted by STANNUS, BASS estimates that one egg per microscopic slide indicates an infection with less than ten worms; and NICOL, in India, gives it as his opinion that to produce effects on the host there must be 500 worms present for six months, though other authorities put this number as low as 50.[8] The largest number of ova per slide in my series was 38. The great majority contained less than 12. Many slides shewed only 1 ovum. The average number in the positive cases, 5·8 per slide. According to the estimates of BASS and NICOL, therefore, none of these cases were heavily enough infected to be prejudicially affected by the parasite.

With a view to finding out the approximate number of worms present in these cases, as well as for the purpose of ascertaining the species of parasite, I examined the stools of several cases whom I had treated. In the absence of a hospital I found great difficulties in the treatment. It was nearly impossible to persuade the patients to abstain from solid food on the day before the administration of the drug, and I found that, in the presence of the enormous masses of material which the intestines of these vegetable feeders contain, the drug had almost no effect on the parasite. Others of my cases went off to their homes before I had obtained the stools which they passed after treatment, and, finally, being unable to keep the cases under my care, I was unable to give such large doses as otherwise I could have done. The drug used was thymol, usually in three 30-grain doses for adults. Such doses are easily borne by the natives.

In ten of the cases examined, the number of worms found varied from 1 to 138, 14 or 15 being the usual number. In all these cases, however, ova were still found in the stools a week after treatment, though in diminished numbers. Case 63, who followed my instructions more intelligently than any of the others, may be taken to form the basis of a calculation. His stools shewed the unusually large number of 33 ova per slide, and 138 worms were found after treatment. A week later the fæces still shewed three ova to a slide, but he was unwilling to undergo

further treatment. Making allowance for some worms which may have been missed in the search, as well as for some which may have undergone digestion, owing to the gradual poisoning with the drug and slow passage through the bowel, as suggested by Bozzolo,[9] one may reckon that 200 worms were accounted for by the treatment. Calculating from the numbers of the ova found before and after treatment, this number of 200 represents ten-elevenths of the total number of worms, and one, therefore, arrives at 220 as the total number originally present. This number accords with Bass's estimate as to the relationship of the number of ova to the number of worms, and this is borne out also by my findings in other cases.

As to the pathological effects, this case, as has been noted, shewed a degree of infection unusually large in my series. In his case, as in one or two others of the more highly infected, a degree of anæmia was present, recognisable by pallor of mucous membrane: no hæmic cardiac murmurs were found in any case examined. In children and young adults a certain amount of any anæmia present must be put down to malaria. A degree of eosinophilia, up to 12 per cent. in some cases (*cf.* Table IIa Case 52, p. 137), is common among natives here; in many, however, this is due, in part at least, to the presence of *Ascaris lumbricoides*, as it is most marked where this helminth is present. I have, however, seen several patients (shewing ankylostome ova) who complained of abdominal and general symptoms, which were probably referable to the ankylostome infection, and where the parasite is so widespread it is to be expected that a certain proportion of the population will be so heavily infected with the worm as to suffer from its effects. The large majority, however, must be regarded as merely carriers; a condition which obtains in other parts of Africa, as well as in India and other countries where the worm is endemic.

The existence of a relative racial immunity has been shewn by the Porto Rico Commission, who found that though Europeans, mulattoes and negroes were infected to nearly an equal degree, the percentage with severe symptoms was much the greatest in the first race and was least in the last.[10]

It is highly probable that such an immunity exists among the natives of Central Africa, where, presumably, the disease has existed for many generations.

SPECIES OF WORM.

Both *Ankylostoma duodenale* and *Necator americanus* were found in the stools examined. The latter seems to be the commoner parasite, as in most of the stools it alone was present. In two cases a third species of Strongylidæ was found, which appears to conform to the description of *Triodontophorus deminutus*. All the material collected is being taken to Dr. LEIPER, of the London School of Tropical Medicine, for examination.

The large percentage of the population affected, together with the comparatively slight degree of infection in each case, accords well with the sanitary habits of the natives. Most of the villages are built close to a small stream or some marshy ground which forms their water supply, and close to which they may grow their green crops in the dry season. As the grass in such places is long, they constitute the natural latrines of the village, for no attempt whatever at sanitation is ever made. The ankylostome larvæ are thus provided with all the requisites of temperature and moisture for their development and continued existence, especially during the rains. Numerous paths traverse these marshy spots, and, assuming the skin to be the usual site of invasion the natives are probably infected either on these paths or during defæcation in the bush, or while working in the moist soil of their wet gardens. Thus opportunities for infection, while obtaining equally for all natives, are not constant in any one case, nor, owing to the scattered position of the houses, is the liability to a heavy infection great. The duration of the life of the ankylostome and necator in the intestine has not been determined, but the longest period stated by MANSON for the ankylostome is three years.[11] As the natives harbour the parasite throughout life from childhood onwards, it is obvious that re-infection must take place from time to time.

The higher percentage of infection here, as compared with Nyasaland, may be due to the higher temperature at this lower altitude favouring the development of the larvæ. Another probable factor, which bears also upon the prevalence of ascariasis, is the undoubtedly more careless habits of the Alomwe in the matter of defæcation, feeding, etc., as compared with those of some of the Nyasaland tribes. On account of their dirty habits the Alomwe are universally looked down upon by these latter, who frequently refuse to eat out of the same dish with them, or

even out of dishes which have been handled by them. The conditions round about the drinking wells in the villages are sometimes remarkably filthy.

In the present condition of the country, where villages and houses are so scattered, the influence of ankylostomiasis upon the general health of the population is probably not great. The disease, however, would be very liable to assume some economic importance, were the country to be opened up to civilisation, and agricultural or other industries to develop, which would cause the collection of large numbers of the population as labour into restricted areas without adequate sanitary provision. All the conditions for massive as well as constant infection would then be present. Such has been the history of ankylostomiasis in Porto Rico and other West Indian islands.

ASCARIS LUMBRICOIDES.

In the 200 cases examined, 128 shewed ova of ascaris, a percentage of 64. The contrast from the conditions in Nyasaland is striking. In STANNUS's series of 505 cases, not a single ovum of ascarsis was found.[7] During four years in Blantyre, I have examined several hundreds of stools, and have not seen ascaris ova in more than 10 or 12 of these. In the present series nearly all the villages shewed cases, but some villages appear to be more heavily infected than others. Children and adults seem to be affected equally. The largest number of ova per slide found was 245, but the number of ova seems to depend upon the size as well as on the number of the worms present. Many cases were treated: among those which I had the opportunity of following up, the largest number of worms expelled from a single case was 15.

TRICHURIS TRICHIURA.

Ova of trichuris were found in 29 cases—14·5 per cent. Ova were always scarce—never more than four to a slide. It is thus probable that cases of infection were missed, and that the percentage infected is higher than represented by the positive findings.

TÆNIA.

Ova were found in 10, or 5 per cent. The species of tape-worm was not ascertained, as I did not have an opportunity of treating any of these cases.

The percentage found does not probably represent the full incidence of infection of the population, as proglottides were not specially searched for in the fæces, only the onchospheres lying free being noted.

SCHISTOSOMA.

Ova were found in four cases. In two of these (No. 8 and No. 33) the ova were lateral spined. In the other two (No. 34 and No. 158), the one ovum found in each case was terminal spined. Cases No. 8 and No. 33 both gave a history of having incurred the infection outside the district, and the former was found to be also suffering from the urinary form of the disease which, he stated, began just after the rectal symptoms had passed off. Among many ova found in his urine, one was lateral spined. Case No. 34 gave no history of dysenteric symptoms, but stated he had suffered from hæmaturia as a child. His urine contained ova, all those seen being terminal spined. I did not have an opportunity of enquiring into the history of case No. 158.

From my experience of dispensary patients, urinary schistosomiasis appears to be fairly common in the district. It is seen in children who have never been away from their villages. I have not, however, come across any locally contracted cases of the rectal form of the disease. Both forms are very common around Blantyre, where I have once seen a terminal spined ovum from the rectum, and once also a lateral spined ovum from the bladder.

OXYURIS VERMICULARIS.

The thread worm appears to be of common occurrence in the district. In the examination of fæces for *Ankylostoma*, I have come across it in small numbers; in 9 out of 11 cases examined, though microscopically, I have encountered its ova in only one case of the 200.

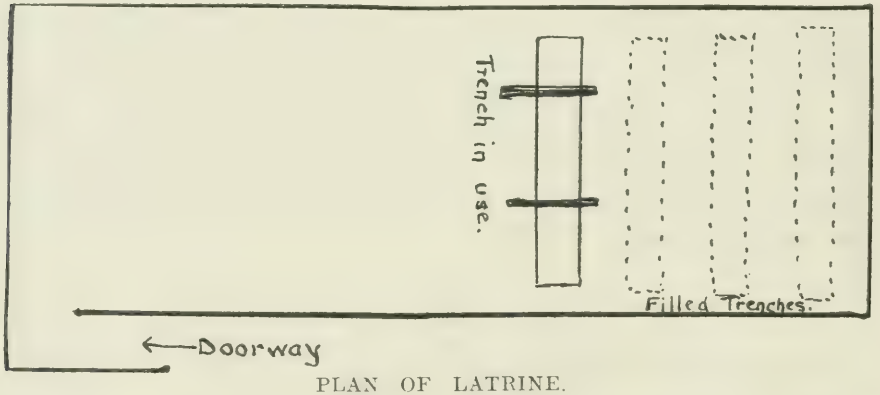
STRONGYLOIDES STERCORALIS.

In the microscopic examination of stools in Blantyre district, the larva of this parasite is frequently met with. It may be worthy of record that it was not once seen in the examination of the 200 stools in this district.

PROPHYLACTIC MEASURES.

Since the settlement of the Mission, from 40 to 60 natives have been constantly employed as raw labour, and about 30 of a permanent staff besides are always on the station. These numbers are likely to be increased in the near future, and brick-making and other similar operations will be undertaken, in which the workers will be in constant contact with mud, possibly infected with ankylostome larvæ. The universal prevalence of ankylostomiasis made it necessary, therefore, to arrange the latrine accommodation with reference to the mode of spread of this disease: the frequency of the *Ascaris lumbricoides* being also borne in mind. In our circumstances nothing elaborate or expensive could be attempted, but the necessities of the case were, I think, sufficiently well met. The deep trench system was adopted, and the plan of the latrine is shewn in the diagram.

Walls are of grass, and the buildings are roofless. Trenches are made about six feet deep, the first trench being dug at the end farthest



PLAN OF LATRINE.

from the doorway. To facilitate defæcation into the trench, wooden cross pieces, on which the native can stand, are laid over the trench. A native is employed to go round the latrines daily and cover in the fæces to a depth of about six inches. As each trench gets filled up a fresh one is dug nearer the doorway, and thus contact of the natives' feet with contaminated earth of the old trenches is avoided. When all the space becomes used up, a new latrine is built in a fresh dry locality.

In the dry season the absence of a roof has everything in its favour. Everything in the trench is baked thoroughly dry by the warm sun,

making conditions impossible for the existence of the larvæ. Even during the rains the advantages—apart from the expense—are in favour of a roofless latrine in suitable soil. Intervals of several days of bright sun, without rain, are frequent, when the superficial soil becomes thoroughly dry. There are several hours of sunshine almost daily throughout, and experiments by JOYEUX, in Upper Guinea, shew that exposure of *Necator americanus* larvæ to two-and-a-half hours of tropical sunlight (? sunshine) kills them.[12] The effect of exposure to sunshine upon pathogenic bacteria, which may be present in the faeces, must also be taken into consideration. A certain amount of mild compulsion has to be imposed on the native to make him use the latrines, and in this connection an enclosure open to the sky is more attractive to him than a roofed building would be.

In the conditions under which the European lives in tropical Africa, the probabilities of infection with ankylostomiasis are not great. Cases, however, have occurred in Nyasaland,[13] and those whose work may expose them to contact with contaminated earth should be warned of the possibilities. Children especially should not go about without shoes during the wet season.

The general hygienic measures adopted on the station, apart from ankylostomiasis and malaria, may be mentioned briefly. For European latrines the bucket system with earth was adopted; buckets being emptied daily into a pit at a distance and the discharges covered in.

All water for drinking and cooking purposes is boiled. My experience of filters, apart from the question of their failure to arrest certain organisms, is, that in the hands of native servants they are very liable to get damaged, and householders are apt to rely upon water as safe which has passed through an inefficient and perhaps dirty filter.

Instructions were given that all fruit and vegetables eaten uncooked should be washed in boiled water. In the disposition of latrines, etc., everything possible was done to prevent the possibility of contamination of the garden area with fæcal matter.

For the prevention of flies, no special measures were taken beyond the ordinary regular sweeping of the station, the burning of refuse and rubbish during the dry weather, and the burying in pits of what could not be burned. Hitherto, flies have not been troublesome.

A lookout is kept for empty tins and bottles, such as might breed

culicine mosquitoes. *Stegomyia calopus* is occasionally seen, but I have found that it breeds in collections of water in the hollow stumps of trees in the forest.

Two other tropical diseases may be briefly referred to before concluding this paper.

SLEEPING SICKNESS AND TRYPANOSOMIASIS.

As previously mentioned, I have unfortunately been unable to obtain a copy of the report of the Portuguese Sleeping Sickness Commission which visited this district among others in 1912, but I met the principal member of the Commission in Blantyre before coming up here, and he informed me that he had not found sleeping sickness in Alto Mólôcuê district, and that tsetse fly of all species were very scarce, though in Baixo Mólôcuê, the administrative district lower down the Mólôcuê River, the fly was widely distributed. Major DO REGO, the chief administrative official of Alto Mólôcuê, has informed me that tsetse fly exists a little to the south of the administrative station, which stands at an elevation of 2,000 feet about 30 miles south of the Mission, and that all his cattle have died from the bite of the fly. I have not come across any species of tsetse in the neighbourhood of the Mission.

Sir DAVID BRUCE, from his experience of *Trypanosoma rhodesiense* in Nyasaland, is convinced that this trypanosome is identical with *T. brucei*, the pathogenic agent of the bovine disease nagana.[14] If, as is probable, the species of tsetse fly present in Alto and Baixo Mólôcuê is *Glossina morsitans* the possibility of human infection with *T. brucei* or *rhodesiense*, as in Nyasaland, will exist, though the common infective agent for animals carried by this fly may be *T. pecorum*.

RELAPSING FEVER (AFRICAN TICK FEVER).

During my residence here I have come across one case of human spirochætosis. Inquiries indicated, however, that the disease was contracted at Quilimane, on the coast, where it is known to be endemic. I have found the spirochæte in the blood of several Nyasaland carriers who had just returned from Quilimane, where, they stated, they had been bitten by the tick, and were severely ill on the return journey back. These men belonged to districts in Nyasaland in which the disease is not endemic.

I have made enquiries among the people of this district, but none of them appear to know the tick or the disease caused by it. In the districts of Nyasaland in which tick fever exists, both the disease and its cause are well known by the natives. From these considerations one may infer that the disease is not endemic here. I have not encountered *Ornithorodoros moubata* in any of my journeys among the villages.

CONCLUSIONS.

In so far as the work recorded in this paper lends itself to the forming of conclusions, these may be summed up as follows:—

Malaria.—The endemic index of the district is over 90, and is probably 100. The commonest parasite appears to be *Plasmodium vivax*, the simple tertian form. Native children may harbour large numbers of parasites in their blood without symptoms.

Ankylostomiasis.—At least 97 per cent. of the population harbour *Ankylostoma duodenale* or *Necator americanus*. The latter appears to be the commoner parasite. The majority of the population are merely carriers.

Ascariasis.—Over 50 per cent. of the population harbour *Ascaris lumbricoides*—adults and children alike.

Trichuris trichiura.—This worm is not nearly so common as the preceding one. It is present in small numbers in about 14 per cent. of the population.

Schistosomiasis.—The urinary form of this disease is common, but the rectal form has not been found, locally contracted.

Tænia.—Tape worms exist, but their frequency and species have not been accurately determined.

Oxyuris vermicularis.—This parasite is probably widely distributed, at least in small numbers.

Spirochætosis.—African tick fever is probably not endemic in the district.

Trypanosomiasis.—Sleeping sickness is not known to exist in the Alto Mólôcuê district. Tsetse fly is sparsely distributed.

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TABLE II.

Examination of Native Children for Malaria, Mwanyewe's Village.

No. of Case.	Sex.	Age.	Spleen.	Malarial Parasites.			Malarial Pigment in Leucocytes.
				Subtertian (Malignant)	Simple Tertian.	Quartan.	
1	F.	10 years ..	Not palpable	—	3	—	—
2	F.	3 months ...	2 inches below C.M....	20	—	—	—
3	F.	4 ,, ...	Not palpable	—	3	—	—
4	M.	4 years ...	2 inches below C.M....	40	—	—	—
5	M.	2 ,, ...	Just palpable	—	—	—	—
6	F.	1 year ...	2 inches below C.M....	—	—	—	—
7	M.	3 years ..	1 inch ,, ..	4	—	—	—
8	M.	3 ,, ...	3 inches ,, ..	2*	—	—	x
9	F.	3 ,, ...	Not palpable	5	10	—	—
10	F.	3 ,, ...	Just ,, ...	—	10	—	—
11	M.	1½ ,, ...	2 inches below C.M....	—	—	—	x
12	F.	4 ,, ...	2 ,, ,, ..	1†	—	—	—
13	F.	4½ ,, ...	2 ,, ,, ...	—	—	4	—
14	F.	14 ,, ...	3 ,, ,, ...	1	—	—	—
15	M.	2½ ,, ...	1 inch ,, ...	—	100x	—	—
16	M.	3 ,, ...	Just palpable	20	2	—	—
17	M.	6 ,, ...	3 inches below C.M....	10	20	—	—
18	M.	2½ ,, ...	1 inch ,, ...	2	—	—	—
19	F.	2 ,, ...	1 ,, ,, .	15	—	—	—
20	M.	1½ ,, ..	Not palpable	4	—	—	x
21	M.	1 year ...	,, ,, ...	1*	—	—	—
22	F.	9 months ..	,, ,, ...	5	—	—	—
23	F.	1 year ...	1 inch below C.M. ...	—	2	—	x
24	F.	2 years ...	1 ,, ,, ...	70	—	—	—
25	F.	2 ,, ...	Not palpable	—	1	—	—
26	M.	3 ,, ...	,, ,, ...	—	12	—	—
27	M.	4 ,, ...	3 inches below C.M....	150†	—	—	—
28	M.	1½ ,, ..	Just palpable	—	1	—	—
29	F.	2 ,, ...	2 inches below C.M....	15	—	—	—
30	F.	1½ ,, ...	2 ,, ,, ...	30	—	—	x
31	M.	5 ,, ...	½ inch ,, ..	60	—	—	—
32	M.	1 year ...	Not palpable	—	—	—	—
33	F.	2 years ...	,, ,, ...	10	5	—	—
34	M.	1½ ,, ...	3 inches below C.M....	—	—	15	—
35	F.	6 months ..	Not palpable	—	—	—	—
36	F.	1 year .	2 inches below C.M....	1*	—	20	—
37	F.	9 months ..	Not palpable	—	—	—	—
38	F.	5 years ..	,, ,, ...	10	10	—	—
39	F.	10 ,, ...	,, ,, ...	5	—	—	—
40	F.	9 ,, ...	1 inch below C.M. ..	—	5	—	—
41	F.	9 ,, ...	2 inches ,, ..	5	—	—	—
42	M.	4 ,, ..	3 ,, ,, ...	20	—	—	—
43	F.	6 ,, ...	1 inch ,, ...	—	5	—	—
44	F.	1 year ...	Just palpable	—	10	—	—
45	M.	5 years ...	2 inches below C.M. ..	—	10	—	—

TABLE II.—*continued.*

Examination of Native Children for Malaria, Mwanyewe's Village.

No. of Case.	Sex.	Age.	Spleen.	Malarial Parasites.			Malarial Pigment in Leucocytes.
				Subtertian (Malignant)	Simple Tertian.	Quartan.	
46	M.	5 years ..	4 inches below C.M....	2	—	—	—
47	F.	6 months ...	2 ,, ,, ...	—	15	—	—
48	M.	9 years ..	Not palpable ...	—	3*	—	—
49	F.	2 ,, ...	,, ,, ...	—	3	—	—
50	M.	6 ,, ...	2 inches below C.M....	—	2	—	—
51	M.	4 ,, ...	1½ ,, ,, ...	—	2	2	—
52	M.	12 ,, ...	Not palpable ...	—	—	—	—
53	M.	2½ ,, ...	2 inches below C.M....	—	2*	—	x
54	M.	6 ,, ...	Not palpable	2	—	—	x
55	M.	4 months ...	,, ,, ...	—	—	—	—
56	F.	2 years ..	2 inches below C.M....	20	20	—	—
57	M.	5 ,, ...	1 inch below C.M. .	—	—	—	—
58	F.	6 ,, ...	Not palpable	2†	—	—	—
59	F.	10 ,, ...	2 inches below C.M....	—	100	—	—
60	M.	1½ ,, ...	Just palpable	—	2	—	—
61	F.	2 ,, ...	,, ,, ...	—	—	—	—
62	F.	1 year ...	1 inch below C.M. ...	—	—	—	—
63	M.	5 years ..	2 inches ,, ...	—	1	1	—
64	M.	2 months ...	1 inch ,, ...	—	1†	—	—
65	M.	2 ,, ...	1 ,, ,, ...	—	3	—	—
66	F.	3 ,, ...	1½ inches ,, ..		20	—	—
67	M.	6 years ..	1 inch ,, ...	—	3	—	—
68	F.	6 ,, ..	1½ ,, ,, ...	—	6	—	—
69	F.	3½ ,, ..	Not palpable	—	3	—	—
70	F.	3 ,, ..	2 inches below C.M....	—	—	20	—
71	F.	5 ,, ..	3 ,, ,, ...	3	—	—	—
72	M.	1½ months...	Not palpable	—	2	—	—
73	M.	6 years ..	1½ inches below C.M...	—	2	—	—
74	M.	6 ,, ...	1 inch ,, ...	—	20	—	—
75	M.	12 ,, ...	1 ,, ,, ...	—	80	—	—
76	F.	13 ,, ...	Just palpable	—	—	—	—
77	M.	6 ,, ...	,, ,, ...	—	1	—	—
78	M.	2 ,, ..	2½ inches below C.M...	10	25	—	—
79	M.	2 ,, ..	2 ,, ,, ...	—	30	—	—
80	M.	3 ,, ..	3 ,, ,, ...	—	8*	—	—
81	M.	1 year ...	1 inch ,, ...	—	120	—	—
82	M.	2 years ...	Not palpable	109	—	—	x
83	M.	1 year ...	1 inch below C.M. ...	—	40	—	—
84	M.	2 years ...	1 ,, ,, ...	—	5	—	—

* Gametocytes found in these cases. † Species of parasite uncertain.

Note.—The numbers in the various columns indicate the approximate number of parasites found in a twenty minutes' search.

TABLE III.

Examination of Fæces of Native Population, Alto Mólôcuè District.

No. of Case.	Number of Ova per Slide.					No. of Case.	Number of Ova per Slide.				
	Ankylostome.	Ascaris.	Schistosome.	Trichuris.	Tænia.		Ankylostome.	Ascaris.	Schistosome.	Trichuris.	Tænia.
1	4	—		1	—	45	10	—		2	
2	11	—				46	1	4		1	
3	5	—	—			47	9		—		
4	7	29				48			—		
5	5	73				49	2				
6		35		—		50	1	—			
7	2		—			51	13	—			
8	3	—	1	—		52	7				
9	10	—				53	14	106	—		
10	1					54	17	42			—
11	14				—	55	16	4		—	
12	8	30				56	2	7			
13	1	3			—	57	5				
14	4	3	—		—	58	8	52	—	2	
15	3	5		1		59	12	174	—		
16		10				60	3				
17	18	61	—	—	—	61	12	126			
18	7					62	5	4			
19	1		—			63	35	33	—		
20	5	3	—	—		64	9	37			
21	2	16	—			65	2	17			—
22	1	—	—			66	2	36		2	
23	5	15	—	—		67	7	15	—		
24	2	—	—	—		68	5	126	—	1	26
25	6	10	—	—	—	69	2	39			
26	3	18	—	—	—	70	9	64		1	
27	4	—	—	—		71	1	—	—		
28	4	51	—	3		72	16	—	—		
29	2	24	—	—	—	73	3	52	—		
30	2	—	—	—	—	74	5	22	—		
31	2	—	—	—	—	75	1	—	—	—	
32	3	95	—	—	—	76	12	34		—	
33	9	73	3	—	—	77	10	27			14
34	14	129	1	—	—	78	21	67	—	—	
35	—	—	—	—	—	79	14	245			
36	7	59	—	1	—	80	6	—		—	
37	2	44	—	—	—	81	20	174	—		
38	8	81	—	—	—	82	17	104	—		
39	1	9	—	—	—	83	5	37	—	1	—
40	2	—	—	—	—	84	3	12	—	—	—
41	—	—	—	—	—	85	2	17	—	—	—
42	2	—	—	—	—	86	1	37	—	—	
43	7	15	—	—	—	87	1	—	—	—	
44	2	40	—	—	—	88	9	—	—	—	—

TABLE III.—*continued.*

Examination of Fæces of Native Population, Alto Mólôcuê District.

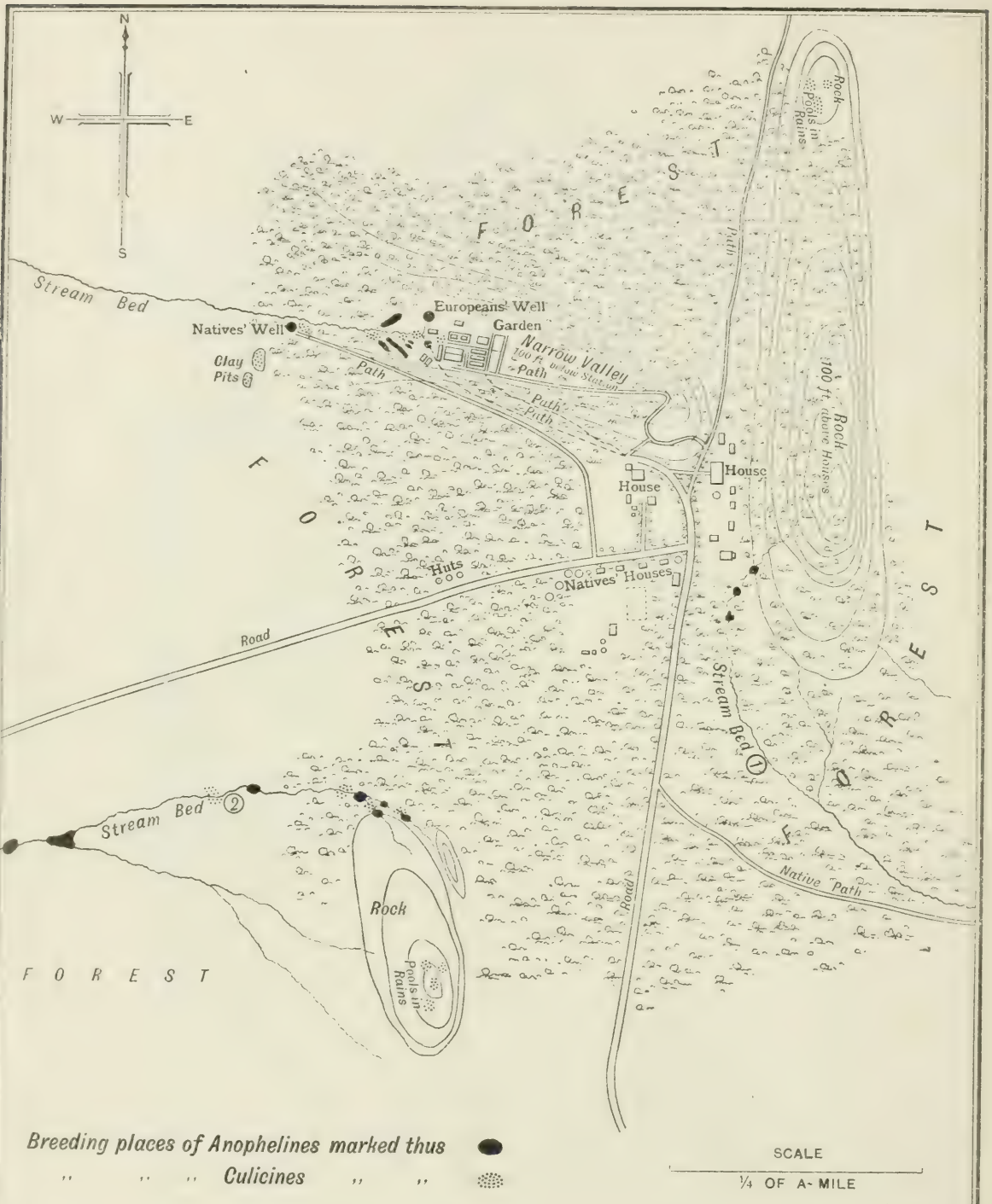
No. of Case.	Number of Ova per Slide.					No. of Case.	Number of Ova per Slide.				
	Ankylostome.	Ascaris.	Schistosome.	Trichuris.	Tænia.		Ankylostome.	Ascaris.	Schistosome.	Trichuris.	Tænia.
89	5	—	—	—	—	133	3	—	—	—	—
90	5	11	—	—	—	134	2	12	—	—	—
91	3	31	—	2	—	135	2	48	—	—	—
92	8	12	—	1	—	136	22	—	—	—	9
93	1	12	—	—	—	137	3	—	—	1	—
94	7	67	—	1	—	138	3	77	—	1	—
95	7	3	—	—	—	139	8	5	—	—	—
96	38	55	—	—	—	140	1	3	—	—	—
97	12	5	—	—	—	141	4	—	—	—	—
98	1	—	—	—	—	142	8	78	—	—	—
99	4	70	—	—	—	143	4	13	—	—	—
100	18	—	—	—	—	144	6	15	—	—	—
101	1	—	—	—	—	145	6	52	—	1	—
102	12	35	—	—	—	146	—	151	—	—	—
103	6	56	—	—	—	147	3	39	—	1	—
104	14	37	—	—	1	148	2	—	—	—	—
105	6	—	—	—	—	149	1	8	—	—	—
106	3	46	—	—	—	150	5	6	—	—	—
107	3	—	—	—	—	151	6	—	—	—	—
108	5	32	—	—	—	152	1	—	—	—	—
109	1	29	—	—	—	153	7	6	—	—	2
110	14	—	—	—	—	154	1	4	—	—	—
111	8	12	—	—	—	155	9	155	—	—	—
112	19	3	—	—	—	156	4	—	—	—	—
113	6	—	—	—	—	157	3	49	—	—	—
114	1	8	—	—	—	158	3	2	1	—	—
115	1	—	—	—	1	159	8	7	—	—	9
116	6	—	—	—	—	160	1	—	—	—	—
117	9	127	—	—	—	161	5	2	—	—	—
118	5	39	—	2	—	162	1	—	—	—	—
119	1	—	—	—	—	163	8	31	—	4	—
120	8	11	—	—	—	164	5	48	—	—	—
121	2	16	—	—	—	165	4	65	—	—	—
122	1	—	—	1	1	166	7	60	—	—	—
123	3	—	—	—	—	167	1	14	—	—	—
124	1	14	—	—	—	168	5	—	—	—	—
125	1	—	—	—	—	169	3	9	—	—	—
126	7	24	—	—	—	170	7	4	—	—	—
127	3	—	—	—	—	171	15	—	—	1	—
128	1	48	—	—	—	172	8	—	—	1	—
129	10	145	—	2	—	173	1	—	—	—	—
130	6	—	—	—	—	174	1	—	—	—	—
131	2	96	—	—	—	175	2	—	—	—	—
132	1	40	—	—	—	176	1	12	—	—	—

TABLE III.—*continued.*

EXAMINATION OF FÆCES OF NATIVE POPULATION,

ALTO MÓLÔCUÊ DISTRICT.

No. of Case.	Number of Ova per Slide.					No. of Case.	Number of Ova per Slide.				
	Ankylostome.	Ascaris.	Schistosome.	Trichuris.	Tænia.		Ankylostome.	Ascaris.	Schistosome.	Trichuris.	Tænia.
177	7	—	—	—	—	189	2	—	—	—	—
178	17	9	—	—	—	190	1	—	—	1	—
179	7	67	—	1	—	191	4	—	—	—	—
180	7	—	—	—	—	192	2	6	—	—	9
181	1	—	—	—	—	193	2	33	—	—	—
182	1	16	—	—	—	194	1	72	—	1	—
183	4	35	—	—	—	195	3	12	—	—	—
184	5	66	—	—	—	196	1	4	—	—	—
185	9	78	—	—	—	197	1	8	—	—	—
186	4	—	—	1	—	198	3	74	—	—	—
187	2	22	—	—	—	199	8	59	—	—	—
188	15	6	—	—	—	200	7	80	—	—	—
				Total Positive Cases ...			194	128	4	29	10
				Percentage Infected ...			97	64	2	14·5	5



MAP OF MISSION STATION, ALTO MÓLÔCUÊ.

To show Mosquito Breeding Grounds, etc.

LIBRARY NOTES.

Under this heading we propose to review recently published works sent us for that purpose, and a short notice of any other works presented to the Library.

Rural Sanitation in the Tropics, being notes and observations in the Malay Archipelago, Panama and other Lands. By MALCOLM WATSON, M.D., C.M., D.P.H. With Illustrations. London: John Murray, Albemarle Street, W. 1915. Price, 12s. net.

Dr. WATSON has rendered a distinct service to tropical medicine by writing the above book. It is a record of the most important work that has been done in tropical sanitation, as regards the destruction of mosquitoes, since the time these insects were incriminated as the carriers and disseminators of malaria and yellow fever, and it takes us up to the present day.

In the introductory chapter, the author states how his unavoidable isolation from fellow-workers was a source of constant anxiety to him, the fear ever being present that his views might become narrow and fixed from constantly seeing the same surroundings, and that his ideas would be altered had he more knowledge of what was going on and being done in other places. These thoughts drove him to visit other lands to see how they were dealing with sanitary problems, and the results of his own work in Malaya, and what he saw and thought of the work of others, are now recorded in the present pages. The book is dedicated to Sir RONALD ROSS, whose epoch-making discovery of the *rôle* played by the mosquito in the propagation of malaria has led to great sanitary activity and scientific investigation of disease throughout the tropics. There are eighteen chapters, as follows:—(1) Introductory; (2 and 3) British Malaya; (4) Quinine Prophylaxis in Italy; (5) Malaria in India; (6) Notes on Sumatra; (7) Hong Kong and the Philippine Islands; (8, 9, 10, 11, 12, 13, 14, 15 and 16) Panama; (17) British Guiana; (18) Barbados; and, finally, an epilogue entitled The Place of Sanitation in Tropical Colonisation. A large part of the book, it will thus be seen, is devoted to

Panama, the Mecca of the modern sanitarian, according to the author. This includes a detailed account of the sanitary organisation, and tells how one of the largest labour forces that the world has seen has not only been built up, but also maintained at a high degree of efficiency, in one of the deadliest climates in the tropics when engaged on a great engineering work.

Dr. WATSON'S own work in Malaya—work of the very greatest importance—comes first. This was of a pioneer nature, and the author had to decide between one or other of the three following methods, viz., mechanical protection, quinine prophylaxis, or mosquito reduction. He began his experiment in a small town called Klang, and, to suit the local conditions, he determined that any expenditure should be on works of a permanent nature, such as draining and filling up swamps. The drainage of the town was to be looked upon as a test case, and it proved to be sound in every respect, as in a couple of years Dr. WATSON was able to report that malaria had ceased to be of any practical consequence. Port Swettenham was next experimented upon, and the results of the operations there were equally satisfactory. Further studies of adjoining districts led to the belief that the reduction of malaria to a negligible quantity was quite possible, and for this agricultural development was what was required: the disappearance of stagnant pools—the breeding haunts of *A. umbrosus*—being followed by a cessation of malaria. Though this applied to the flat coastal zone, it was quickly found, however, that it did not to the hill estates, so a careful examination was carried out in these areas. This resulted in an anopheline with different habits (*A. maculatus*) being detected as the carrier of the disease—an insect which breeds in clear springs and crystal brooks, and cannot be eradicated by weeding the edges of the streams. Different measures had to be adopted, therefore, to meet the case, and, finally, an ingenious system of pipe drains was developed.

How Kuala Lumpor, the Federal Capital, was also freed from malaria by Mr. EVANS, Engineer to the Malaria Advisory Board, is also described, and some useful rules for Estate Sanitation are also given here.

Passing over the chapters on Italy and India, that on Sumatra is reached, and this forms very instructive reading. The Dutch have taken up the matter of the prevention of malaria and other tropical diseases in great detail, with excellent results. Their hospitals, according to

Dr. WATSON, are of the best; they have a splendid Medical Institute, and their estates are in a first-rate condition, with little or no malaria present. Their work is indicative of energy and progression, and similar steps might well be followed in other colonies.

The chapters on Panama must be read to be appreciated. It is a wonderful record, and one wonders what would have happened if President Roosevelt had sent a "practical man" instead of one who wasted time and money in fighting mosquitoes. The success of the work is largely due to him for not only having supported Colonel GORGAS, but also for having raised him to a seat on the Canal Commission. Unless this had been done, sanitation would have been hampered, and the work would never have been carried out. How near failure it really was may be appreciated if one reads page 115 of Dr. WATSON's book. When 62 cases were reported in June, 1905, a panic only was averted with the greatest difficulty. The overcoming of this outbreak was indeed a triumph for Colonel GORGAS.

Turning finally to the chapters on British Guiana and Barbados, it is clear to those who know those areas that a more prolonged visit by Dr. WATSON might have modified his views considerably. It seems somewhat optimistic to say that in this part (Corantyne Coast) of British Guiana agriculture has in some way, for all practical purposes, extinguished malaria. Though perhaps not so malarious as the Malay Peninsula, yet British Guiana cannot be considered a health resort in this respect. Dr. WATSON says on page 274 that in a closed trench next the hospital no larvæ were found. This shews the danger of generalising on one observation; the present reviewer used to use this same trench for the collection of anopheline larvæ for experimental purposes many years ago.

As regards Barbados, there are other collections of water which Dr. WATSON did not see, and in which mosquito larvæ lived. The writer of this note went into the subject of the absence of anophelines from Barbados, in detail in 1900, and Dr. WATSON quotes some of those results now. Experiments carried out with "millions" in artificial collections of water, shewed that these fish did feed greedily on mosquito larvæ and pupæ, but that in natural collections, even though present in large numbers, larvæ of different culex mosquitoes (*Melaconion atratus*, etc.), nevertheless occurred. Such being the case, it did not seem necessary

to reply to the letter of Mr. GIBBONS in 1905, as this author had evidently not studied the subject in detail, and his observations were therefore valueless. Though fish play a part in keeping down the numbers of mosquitoes, they cannot, or at least do not, exterminate them in natural collections of water.

An epilogue, entitled The Place of Sanitation in Tropical Colonisation, closes this very excellent work. Here the sanitarian is invited to take a broad view of life, and is further counselled to strive to realize what the difference between surplus and deficit really is; and to remember that, since sanitation is primarily a question of ways and means, he must cut his coat according to his cloth. These are wise words, and future sanitarians would do well to note them carefully.

Dr. WATSON'S work then is an excellent one, and many first-rate photographs help to enhance its value. All interested of course in tropical sanitation must read it. It is hoped that these few notes put together here will direct the attention of workers in the tropics to it and whet their appetite to peruse and study its pages themselves.

G. C. Low.